Space Weather Technical Forecast

Issued on Tuesday, 18 June 2024 at 00:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Isolated M-class flares (R1-R2 radio blackouts) Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Stop Press: At the very end of this reporting period a large helicodical prominence eruption was observed from the northeastern limb (around 17/2330UTC). No coronagraph imagery is available at present to assess any resulting CME, however provisionally Earth impacts are felt to be unlikely. Elsewhere, the solar wind also showed a resurgence to 550km/s at ACE – tentatively related to a resurgence in CH45/+.

Solar Activity: Activity has been Moderate, with three low-end M-class flares observed at GOES16, the largest of which was an M1.5 at 17/0804UTC from AR3712. Other significant flares included a second M1.5 from near the leader of AR3712 at 17/1046UTC and a longer-period M1.3 from 3711 at 17/2024UTC.

There are currently six sunspot regions on the facing side, with AR3717 in the western solar hemisphere having faded to plage in the period. The largest and most complex regions currently straddle the solar meridian. All three of these groups showed some changes in recent hours, with AR3716 showing proliferation and diffusion in its trailers, with these eventually forming a ring shape into the UTC evening. Further south, AR3713 showed areal growth and proliferation of many minor intermediate spots, while AR3712 developed further mature penumbral spots in its centre, remaining the most complex and retaining its Mt Wilson delta spot(s). The remaining groups appeared as unremarkable dipoles or monopoles near the western solar horizon, however this perhaps belies some complexity as evidenced by the late M1.3 from AR3711, which otherwise presents as a plain Bxo/Beta.

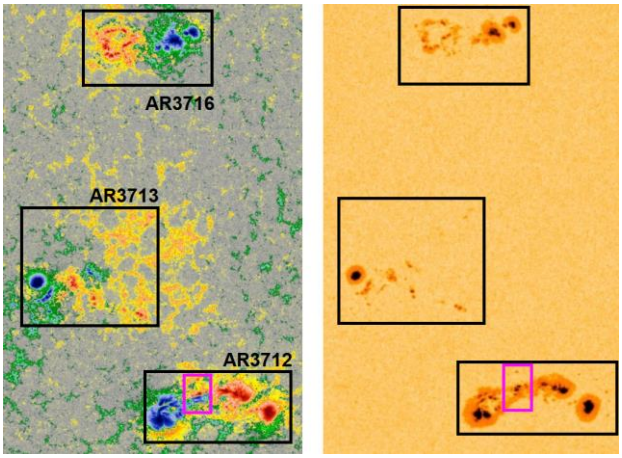

Figure 0: SDO HMIBC and HMIIF from 17/2300UTC showing the three most complex sunspot regions near the solar meridian. For scale, Earth fits inside the umbra of the main spot in AR3713. Note the Mt Wilson delta spot boxed in magenta in AR3712.

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No clearly Earth-directed CMEs were in evidence in available imagery at time of issue. A Type-II radio burst was recorded at 17/1100UTC with an associated estimated speed of 411km/s. The fact that this is a slight mismatch in timing for the AR3712 M1.5 flare at 17/1045UTC, and the fact that the front-sided flare was very impulsive (versus long-period) has led to the conclusion that this radio burst was probably associated with the shock to the far northeast of a near-concurrent far-sided full halo CME event.

Far-sided activity has dominated the limited offering of Lasco coronagraph imagery in the period, with events to the far southeast at 17/0800UTC and far-central-northeast 17/1100UTC perhaps linked in part to Ex-AR3797, which delivered X-class activity on its last crossing of the front side.

Solar Wind / Geomagnetic Activity: Solar winds, as measured at ACE at L1 were generally Slightly Elevated in the period and perhaps most reflective of ongoing fast wind influence from CH45/+. There were two discontinuities seen in many measures observed at 17/0300UTC and again at 17/1400UTC with uncertain mechanisms, although these were in any case minor. ACE EPAM LEMS showed little of interest through these events and they may therefore be best ascribed to natural variation within the current fast wind regime.

The solar wind speed was initially stable at 450km/s before undergoing a step-wise increase to 525km/s after 17/0300UTC, waning to 425km/s over the ensuing nine hours. A second jump to 475km/s was then seen at 17/1400UTC, levelling back to 450kms by the period's end. The solar wind density was unremarkable through these changes, remaining within normal background single-figure ppcc. The IMF envelope varied between Background and Slightly Elevated levels, peaking at 11nT, but occasionally as low as 3nT. The north-south component was more stable and showed a gradual drift from mainly positive values and +6nT to reach a nadir of -10nT in the UTC afternoon before moderating. The phi angle was predominantly positive (away from the Sun) throughout these changes, with the most lasting foray into negative between 17/0500-0700UTC.

The net result of the above solar wind measures was for provisionally Quiet increasing Unsettled geomagnetic activity, with a peak of Kp '3+' in the 18-21UTC interval.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background levels, despite the M-class activity.

High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background levels, with the associated 24-hour fluence well below Active. Observed fluence at 18/0001UTC was 9.21e5 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flares are Likely, with a Slight Chance of isolated X-class flares. No significant regions depart in the period, however the prospect of some significant regions returning around midweek may serve to slightly raise the daily risk of flares from Wednesday 19 June.

Solar Wind / Geomagnetic Activity: No CMEs feature in the current forecast, and the current fast wind is the only one expected in the four days. Slightly elevated solar wind speeds from CH45/+ are expected to continue at first, before declining back to background through UTC midweek. Geomagnetic activity is expected to fall from current levels, with mainly Unsettled and a Slight Chance of Active intervals at first, becoming Quiet from midweek.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at

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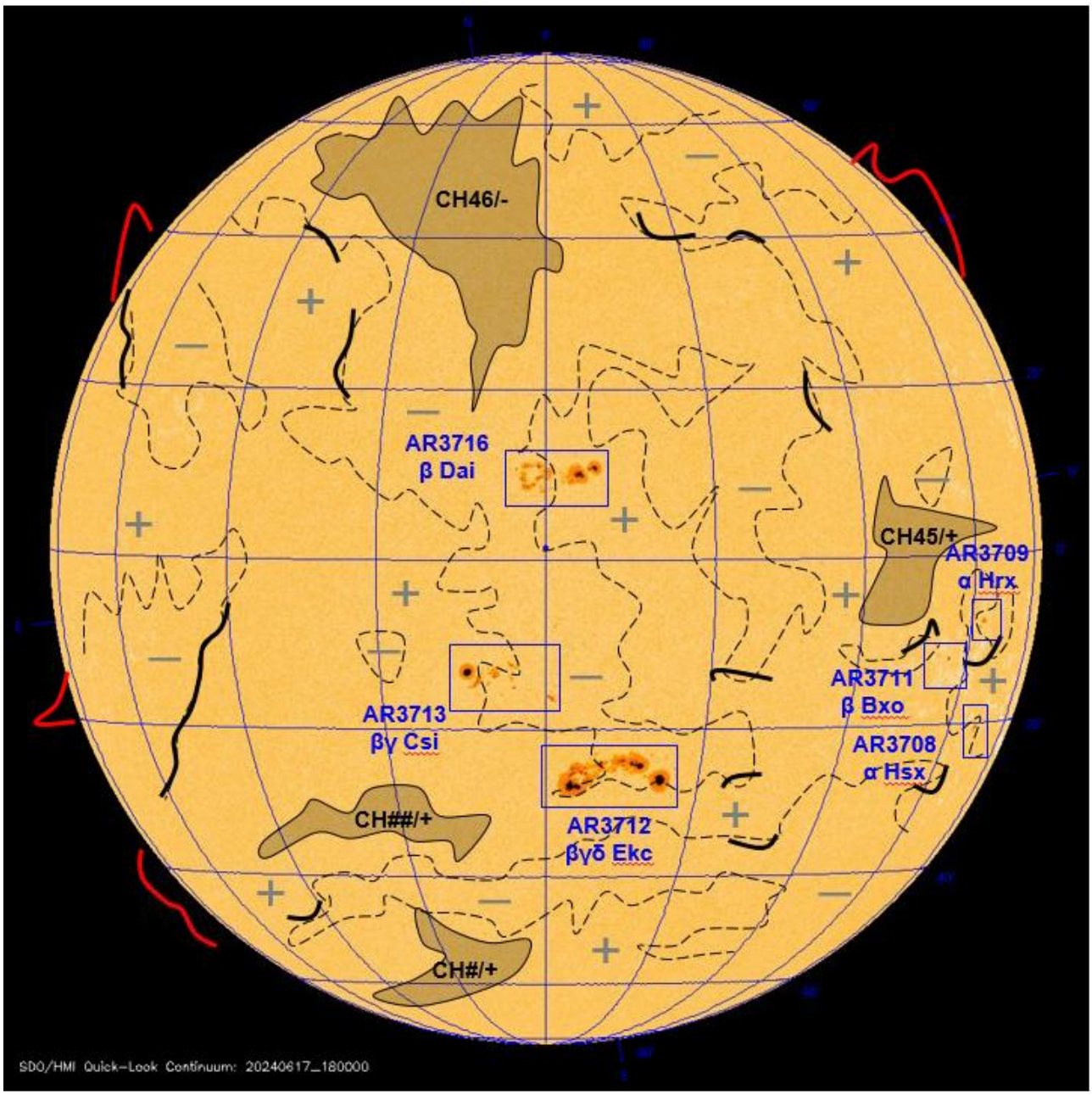
Background levels, with a Slight but increasing chance of reaching S1 levels following any significant flares.

High energy electron flux is forecast to persist at predominantly Normal Background levels, and the associated 24-hour fluence is expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 17/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in the forecast, and the sole coronal hole fast wind is currently in course.

Slightly elevated solar wind speeds from CH45/+ are expected to continue at first, before declining back to background through UTC midweek. CH45/+ is felt likely to have peaked, and with the solstice (the semi-annual minimum geoeffectivity of any polarity coronal hole) within this forecast period (20 June), it has thus far only shown a muted geomagnetic effect despite Elevated peak speeds of near 525km/s. The observed solar wind signature has been quite erratic from this feature, perhaps reflective of a hesitant connection with Earth. This may be related to Earth transiting near the current sheet given the occasional switch to negative phi angle (from the expected positive from CH45/+).

Geomagnetic activity is expected to fall from current levels, with mainly Unsettled and a Slight Chance of Active intervals at first, becoming Quiet through and from midweek.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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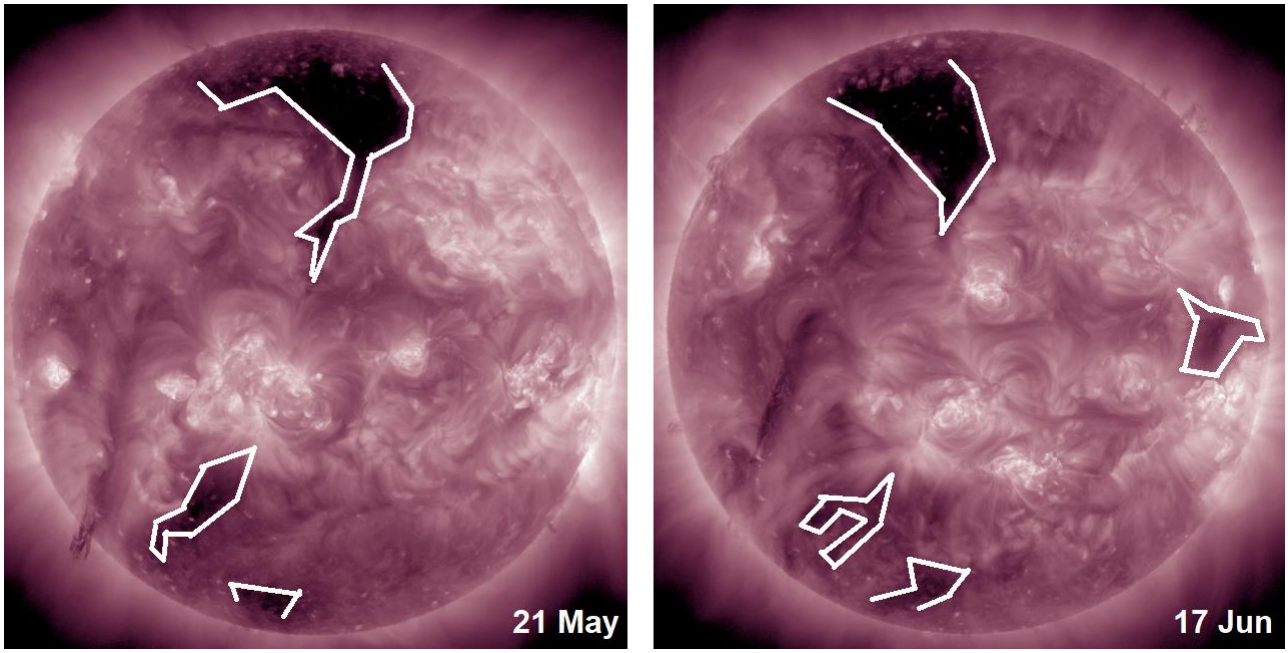
Figure 2: SDO/AIA 211 imagery comparison between the current rotation (right) and the last. Note that CH45/+ is a non-persistent feature. CH46/- in the north has retrogressed since last pass – this would hint at a later arrival at Earth if present, however MOSWOC Enlil's forecast arrival time of later in the current UTC day is not thefavoured solution – something nearer persistence in an unaffected continuation of sub-400km/s speeds is instead preferred throughout.



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Radio Blackouts - X-Ray Flares:

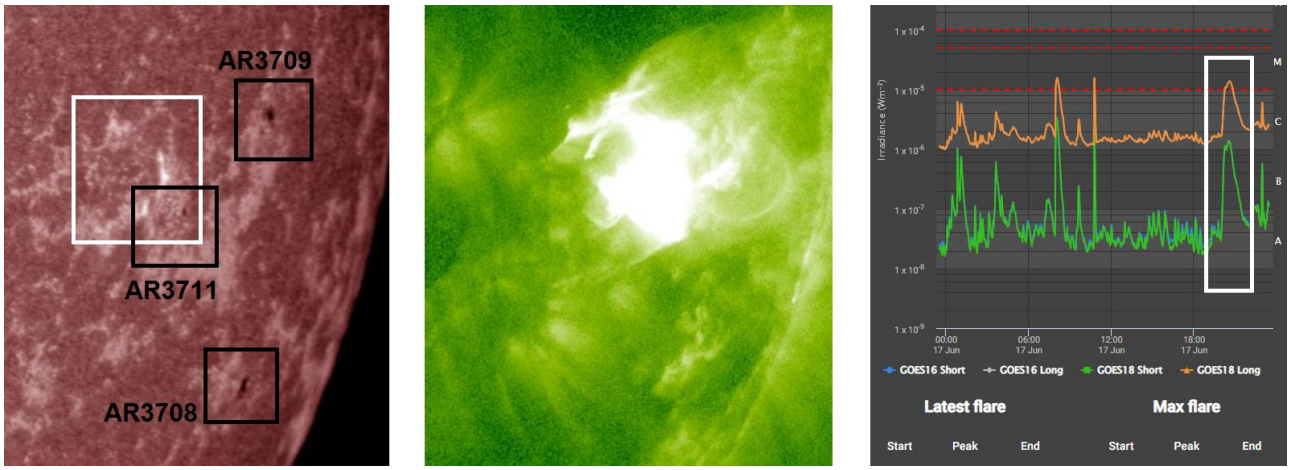
The current frontside comprises two main clusters of active regions - firstly and most notably a complex trio near the solar meridian that includes the most active region of late, AR3712; and secondly a trio nearing the western solar horizon that are visibly simple. The first population should remain on the current disc throughout the four-day period and contributes the majority of the daily Likely M-class flare risk. The southwestern cluster should progressively rotate off through midweek, to little expected impact on risks, although the recent M1.3 from AR3711 means it may be starting a growth phase and will warrant monitoring.

In terms of oncoming regions, a cluster including M-class producing Ex-AR3790 is due onto the Earth-facing side midweek, which should offer a slight increase in daily flare probabilities assuming that some complexity is maintained here. Recent far-sided haloes are assumed to have some link to Ex-AR3797, which produced X-class activity but remains a week away from the eastern limb.

Overall, M-class flares are considered Likely with a rise after the first 24-hour period the result of eastern limb arrivals, with a Slight Chance of X-class throughout.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	60	70	70	70
Very Active	**R3 to R5 X Class**	No	10	10	10	10

Figure 3: Imagery and GOES16 X-ray trace for the M1.3 flare from AR3711 (white boxed) – respectively SDO AIA 1600, 094 and GOES16. Note the relatively simple presentation of AR3711 – not significantly different from its unipolar neighbouring regions.



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux is at Background levels. While there is no recent evidence of any GOES18 proton response from recent M-class flares, the far-western solar longitude of AR3711 and the proximity of its 17/2034UTC M1.3 flare to the issue time of this document has led to initial residual risk of S1 into Day one (Tuesday 18 June), although this is now becoming less likely (given the ongoing lack of response at the time of writing).

Assuming this flare event is a one-off, the risk should soon relax back to the raw disc value. From here, the very gradual increase in risk then resumes as the trio of solar meridian-occupying sunspot groups continue their advance westwards. Little is offered by the spot groups on the southwestern horizon, however this opinion may be revised should AR3711 continue with M-class activity.

Radiation Storms Probability (Exceedance)	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC) (%)**	**Day 2 (00-24 UTC) (%)**	**Day 3 (00-24 UTC) (%)**	**Day 4 (00-24 UTC) (%)**
Active	**≥ S1**	No	15	10	10	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux is expected to persist at mainly Background levels, although some diurnal Moderate flux values are likely in the wake of the current fast wind.

No feature in the last rotation has proven capable of generating Active electron fluence, and despite not being a persistent feature, the limited strength of CH45/+ is unlikely to buck this trend. The associated 24-hour fluence is therefore expected to remain below the Active threshold throughout (1e8 integrated pfu). MOSWOC REFM is considered to provide reasonably good guidance in the near term.

GEO Electron Environment Probability (Exceedance)	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC) (%)**	**Day 2 (00-24 UTC) (%)**	**Day 3 (00-24 UTC) (%)**	**Day 4 (00-24 UTC) (%)**
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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